Assessment of Surface Soils Surrounding the SL-1 Burial Ground

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1. INTRODUCTION

The purpose of this report is to summarize the results of the baseline risk assessment (BRA) performed for the surface soils surrounding the Auxiliary Reactor Area (ARA)-I and II facilities. The assessment originally appeared in Section 12 of the draft report titled *Remedial Investigation/Feasibility Study (RI/FS) Report for Operable Unit (OU) 10-06: Radionuclide-Contaminated Soils at the Idaho National Engineering Laboratory* (Haney et al., 1994). The section was removed in subsequent revisions of the report. The current version of this draft report, with the same title, was issued April 1995 and is referenced as Jessmore et al. (1995).

To preserve the BRA, Section 12 of the original draft OU 10-06 RI/FS report and pertinent portions of the associated appendices were included in an engineering design file (EDF) titled *ARA Windblown Area Risk Evaluation* (Jorgensen, 1995). After the EDF was issued, a new more comprehensive set of dose equivalent rates was acquired. The EDF (Jorgensen, 1995) was subsequently revised to include these data as well as to revise the original Section 12 for clarity and accuracy. Information from the EDF will be used to support a no-further-action recommendation for the surface soils around the SL-1 burial ground, thus eliminating the need to further address potential surface soil consolidation issues for the future remediation of the SL-1 burial ground. The EDF is a companion document to this report and is frequently referenced.

The EDF addresses windblown contamination in the area surrounding (but not including) the ARA-I and ARA-II facilities, and the ARA-III facility area. ARA-III is not related to the SL-1 burial ground; therefore, information regarding ARA-III will not be included in this discussion. ARA-I and ARA-II are immediately adjacent to each other and are close to the SL-1 burial ground. The defined area of investigation around these two facilities includes the SL-1 burial ground and is the focus of this discussion. In particular, the northeastern portion of the windblown area around ARA-I/II, approximately 40% of the total area examined in the OU 10-06 study, will be included in remedial decisions for OU 5-05.

2. SITE DESCRIPTION AND BACKGROUND

The SL-1 reactor was part of the facility now known as ARA-II, located as illustrated in Figure 1 in the south-central portion of the Idaho National Engineering Laboratory. The SL-1 reactor was operative from August 1958 until January 3, 1961, when it was destroyed by a nuclear accident. A burial ground was constructed approximately 488 m (1,600 ft) northeast of ARA-II for the permanent disposal of contaminated materials, debris, and soil resulting from the accident and cleanup efforts. Although the accident was contained by the reactor building, cleanup operations resulted in the spread of contamination over surface soils adjacent to the facility, the area of the SL-1 burial ground, and the region between. More than 30 years have passed since the accident and cleanup. Surface contamination, primarily in particulate form, was further dispersed by wind in the intervening years.

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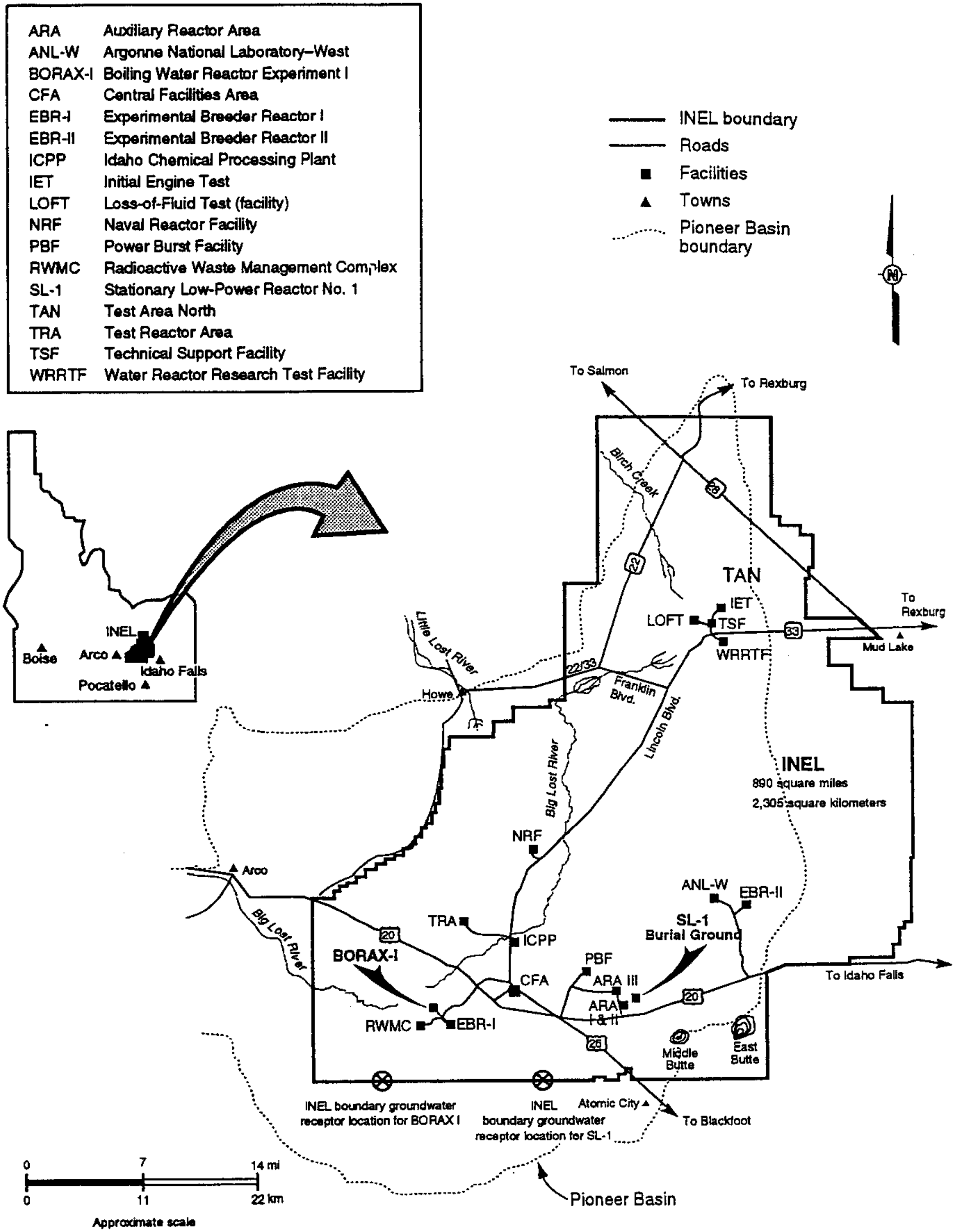


Figure 1. Location map of the Idaho National Engineering Laboratory (INEL).

The contaminated soil area is defined by the outer isopleth illustrated in Figure 2. For investigative purposes, this area is divided into two regions. The northeastern surface soil area, defined by the existing radiological control fence on three sides and an arbitrary boundary on the southwestern side, has been incorporated into the SL-1 burial ground site (ARA-06, OU 5-05), as illustrated in Figure 3.

A comparison of Figures 2 and 3 indicates that the area defined for OU 5-05 in Figure 3 by the radiological control fence does not encompass the entire northeastern lobe of the plume defined by the outer isopleth in Figure 2. Nonetheless, the entire northeastern portion is addressed in this report. The southwestern portion contains the ARA-I and ARA-II facilities and the surface soils not included in the SL-1 Burial Ground study. A new WAG 5 site, ARA-23, has been designated to address surface soil contamination at ARA-I and ARA-II. The southwestern area of the windblown contamination area, roughly 60% of the area defined by the outer isopleth in Figure 2, comprises ARA-23. The surface soils within the ARA-I and ARA-II facility fences are included.

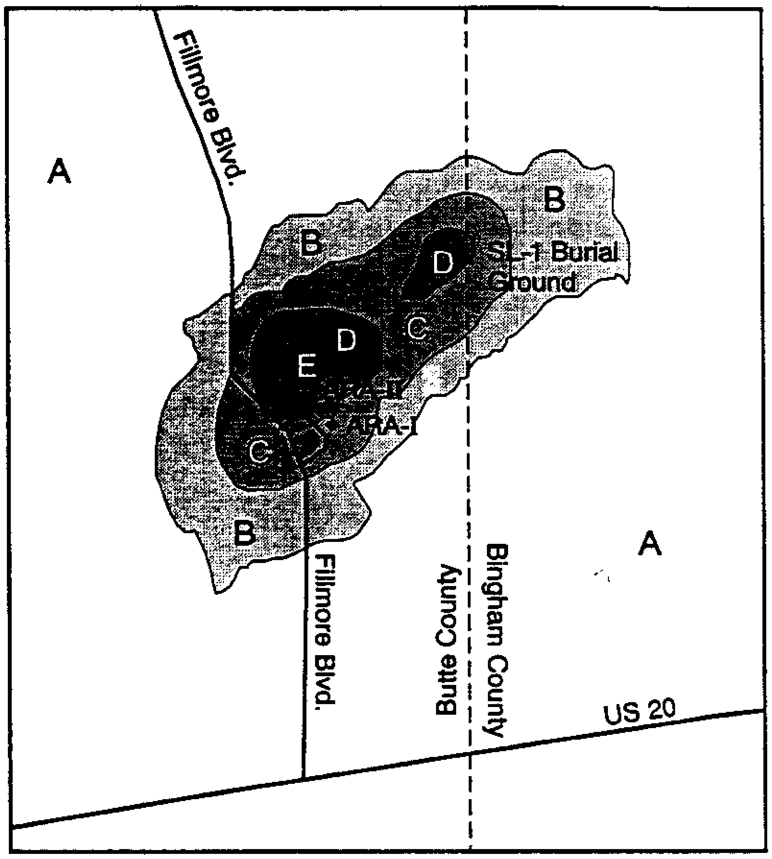
Surface soils adjacent to the burial ground were incorporated into the SL-1 RI/FS report for OU 5-05 (Holdren et al., 1995) because of anticipated difficulties with creating a clean island in the middle of a contaminated soil area and potential cross-contamination issues. Existing sample data were used for the OU 5-05 BRA. This same area was also assessed in the original draft OU 10-06 RI/FS report, and consequently in the EDF. Data obtained from Radiological and Environmental Sciences Laboratory (RESL) monitoring conducted in 1977, 1985, and 1991 provided the majority of information for the OU 10-06 study. In 1993 in an operation described as OU 10-06 Phase I sampling, three samples were collected from the northeastern end of the region in support of the OU 10-06 RI/FS. In July 1995 additional dose equivalent rate measurements were taken. All three data sets were used in the revised BRA included in the EDF and this report.

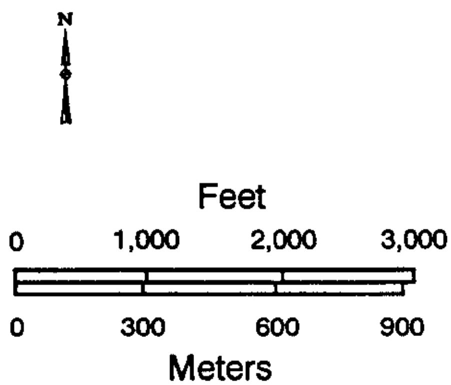
The OU 5-05 RI/FS report and proposed plan are final, and the Record of Decision for OU 5-05 is currently under agency review. Results from the OU 10-06 study were not available for incorporation into the OU 5-05 RI/FS report. The results, summarized here, are intended to support the OU 5-05 Proposed Plan and Record of Decision.

3. OU 5-05 RI/FS REPORT RISK SUMMARY

As shown in Figure 3, the OU 5-05 RI/FS report used the existing radiological control fence to define the limits of the operable unit on the north, east, and south sides. The western boundary was arbitrarily estimated. Section 6 of Holdren et al. (1995) contains the results of the BRA.

Originally, the SL-1 burial ground site was defined as the area within the burial ground exclusion fence. However, issues were raised concerning the development and defense of the risk assessment because of possible cross-contamination issues associated with the creation of a "clean" area, the remediated burial ground, surrounded by unremediated contaminated surface soils. To address these issues, the decision was made to expand the site from 91 by 183 m (300 by 600 ft) to 366 by 457 m (1,200 by 1,500 ft) to include adjacent surface soils. Both surface and subsurface areas were addressed in the same BRA.





Letter Label	Counts per Second
A	< 1,100
B	1,100 - 3,500
C	3,500 - 11,000
D	11,000 - 35,000
E	35,000 - 110,000

Preliminary Data Results. The data shown here have been processed in a manner that suppresses the natural background. The results are displayed as relative levels of manmade radionuclide activity. It is nearly impossible to convert the relative levels of activity to a meaningful exposure rate because of the complex distribution of the nuclides.

Figure 2. 1990 isoplethic map of SL-1.

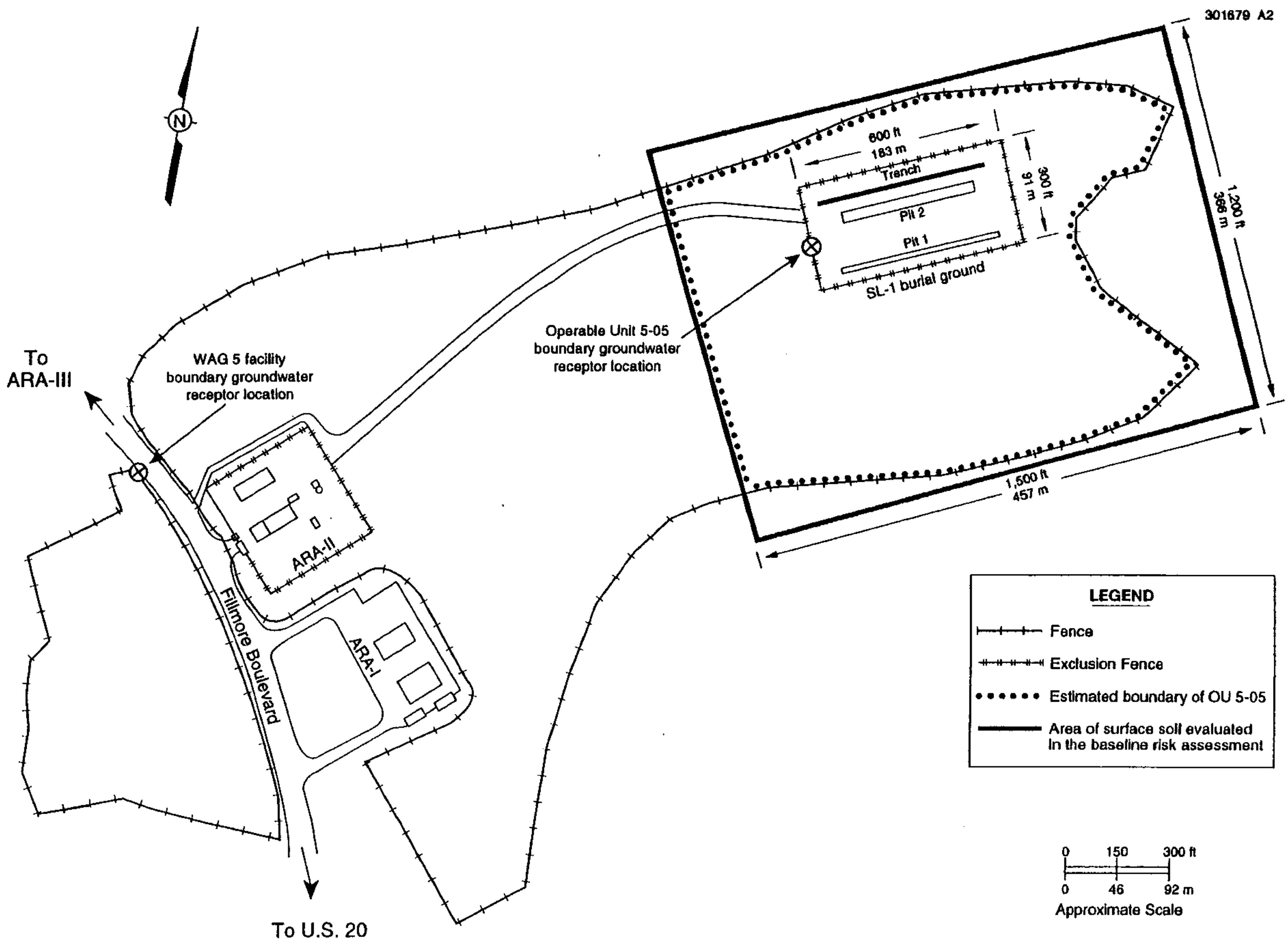


Figure 3. Diagram of the SL-1 burial ground relative to the ARA facilities.

Existing soil sample data were used to estimate an upper bound on the surface soil source-term concentrations for ingestion-of-soil and inhalation-of-dust pathways. Highest detected concentrations from other previous sampling activities were used as homogeneous concentrations in the BRA for the entire 366-by-457-m (1,200-by-1,500-ft) area to a depth of 0.15 m (0.5 ft). At the time, the RESL data and the new data acquired for the OU 10-06 BRA were not available.

The external exposure and groundwater ingestion pathways were assessed using source-term concentrations generated by the ORIGEN-2 computer code. Track 2 default parameters were used; Track 2 guidance specifies a route depth of 1.2 m (4 ft) for nonintrusive external exposure pathways. For the SL-1 site, this assumption models direct exposure to contaminated wastes.

Based on the results of the OU 5-05 RI/FS report, potentially unacceptable risks exist at the site. Deterministic risk values for nonintrusive occupational and residential scenarios are given in Table 1. The primary risk driver is Cs-137 in the external exposure pathway. Sr-90 is of secondary concern in the ingestion-of-soil pathway. These risks were calculated using standard EPA methodology for deterministic risks. Additional information concerning the development of these data and an uncertainty discussion can be found in Section 6 of Holdren et al. (1995).

A subsistence farmer scenario for water-independent pathways 100 years in the future was also evaluated. The RESRAD computer code was used to assess risks for this scenario. Results appear in Table 2. More details can be found in the OU 5-05 RI/FS report.

Table 1. Nonintrusive[a] (surface exposure) risks from the SL-1 burial ground and surrounding contaminated surface soils as estimated in the SL-1 BRA.

Pathway	Current occupational	100-year future occupational	30-year future residential	100-year future residential
External exposure[a]	2E-01	3E-02	5E-01	1E-01
Ingestion of soil	2E-05	2E-06	5E-05	9E-06
Inhalation of dust	4E-07	2E-07	4E-07	3E-07
Ingestion of groundwater	NA[b]	NA[b]	1E-06	1E-06
Total risk	2E-01	3E-02	5E-01	1E-01

a. Route depth of 1.2 m (4 ft) using source terms generated by the ORIGEN-2 computer code were used to assess risks from the external exposure and groundwater ingestion pathways. Wastes exist at a depth of 0.6 m (2 ft); therefore, the modeled receptor is directly exposed to contamination.
b. Not applicable. Groundwater ingestion is not considered for occupational scenarios unless the potable water source is directly downgradient from the site.

Table 2. Subsistence farmer risks 100 years in the future as estimated in the SL-1 BRA.

Pathway	Risks
External exposure	1E-03
Ingestion of soil	4E-07
Inhalation of dust	2E-06
Ingestion of plants	1E-05
Ingestion of meat	4E-05
Ingestion of milk	1E-05
Total scenario risk	1E-03

4. SUMMARY OF THE CONTENTS OF THE EDF

The EDF addresses the windblown contamination area defined by the outer isopleth encompassing ARA-I, ARA-II, and the SL-1 burial ground illustrated in Figure 2. Data defining the isopleths in the figure were generated by a 1990 areal radiological survey. The EDF reports the results of the baseline risk assessment performed for this region of windblown contamination.

The BRA was conducted to define the contaminated area and quantify potential risks to human health and the environment. Of specific pertinence to the SL-1 burial ground investigation are data, risk quantifications, and conclusions regarding the northeastern portion of the windblown contaminated soil area. The study addressed the site as a whole and did not segregate the site into separate regions of interest.

Details concerning previous studies, including areal and radiological surveys, and sampling, can be found in the EDF. Physical characteristics (surface features, meteorology, hydrology, etc.) of the site are also described. Except for the RESL data, the Phase I sampling, and the dose equivalent rate data, the bulk of this information is presented in the SL-1 RI/FS report and is not summarized here. Site-specific information, including the RESL data, OU 10-06 Phase I results, and the July 1995 dose equivalent rates used in the BRA, is contained in the EDF and summarized below.

4.1 ARA Windblown Area Nature and Extent of Contamination

The contaminants of potential concern (COPCs) consist of detected constituents that either are present in concentrations greater than background values or for which no background values exist. Cs-137, Pu-238, and Pu-239/240 were retained in the risk analysis because detected concentrations are greater than the upper tolerance limit given in Rood et al. (1994) for background. Co-60, Eu-152, Eu-155, U-233, and U-235 were identified as COPCs because concentrations of these contaminants were detected and no background concentration values exist. Sources of these radionuclides in the ARA-I/II vicinity were the 1961 SL-1 reactor accident and ARA operations conducted from 1950 to 1988. Atmospheric dispersion, occurring over the course of several decades, spread contamination over local surrounding surface soils.

Phase I samples and RESL data from 1977, 1985, and 1991 were used to characterize the nature and extent of contamination in the windblown area and to perform the BRA. The Phase I samples, collected at a depth of 0–10 cm (0–4 in.), were analyzed for Cs-137, Pu-238, Pu-239/240, and Sr-90. Cesium was the only contaminant detected, with detections in each sample greater than the 0.81-pCi/g background established in Rood et al. (1994). The combined RESL data set also yields concentrations of Cs-137 above background. Other radionuclides detected in concentrations greater than background values are Pu-238 at two locations, one detection of Pu-239/240, and Sr-90 at 15 locations. In addition, concentrations of Co-60 at 14 locations, Eu-152 at one location, Eu-155 at four locations, U-233 at four locations, and U-235 at five locations were detected by RESL. These data were collected at depths of 0–5 and 5–10 cm (0–2 and 2–4 in.).

Dose equivalent rate measurements were also collected during Phase I. These data were collected at sample locations no less than 610 m (2,000 ft) from the ARA-II facility. Many are outside of the outer isopleth that defines the windblown area. Consequently, new dose equivalent rate measurements were acquired in July 1995 to fully characterize the entire area within the isopleth.

The evaluation incorporated the assumption that the vertical extent of radionuclide contamination in the ARA windblown area is confined to the top 10 cm (4 in.) of soil. This assumption is based on the results of RESL data, which indicate that the majority of contamination is in the top 10 cm (4 in.), and the knowledge that atmospheric dispersion was the transport mechanism.

RESL samples are located on a radial grid with the center on the original SL-1 reactor site. Sample locations are described by an angle (due north from the original site is 0 degrees, and rotation is clockwise) and by a distance from the original SL-1 site in feet. Samples have been collected on vectors from the origin every 22.5 degrees at distances of 250, 500, 1,000, 1,500, and 2,000 ft. Most vectors were also sampled at 2,500 ft, and additional samples were taken on selected vectors up to 3,500 ft. Phase I samples were located to address a potential data gap in the sample coverage to the northeast of the reactor site. These data were used to characterize the horizontal extent of contamination. A summary of the results is given in Table 3. The 1995 dose equivalent rate measurements were taken at approximately the same locations as the RESL samples, and are summarized in Table 12-5 of the revised EDF.

The soils data indicate that contaminant concentrations are highest in the immediate vicinity of ARA-I/II, with concentrations decreasing with increasing distance. Sampling activities focused on Cs-137 because it is well-distributed throughout the windblown area and has been identified as the primary risk driver. Therefore, the horizontal extent of contamination is described by the outer isopleth in Figure 2, which bounds Cs-137 concentrations to a maximum of 5 pCi/g. Figure 4 illustrates the isopleth, existing fences, and sample locations.

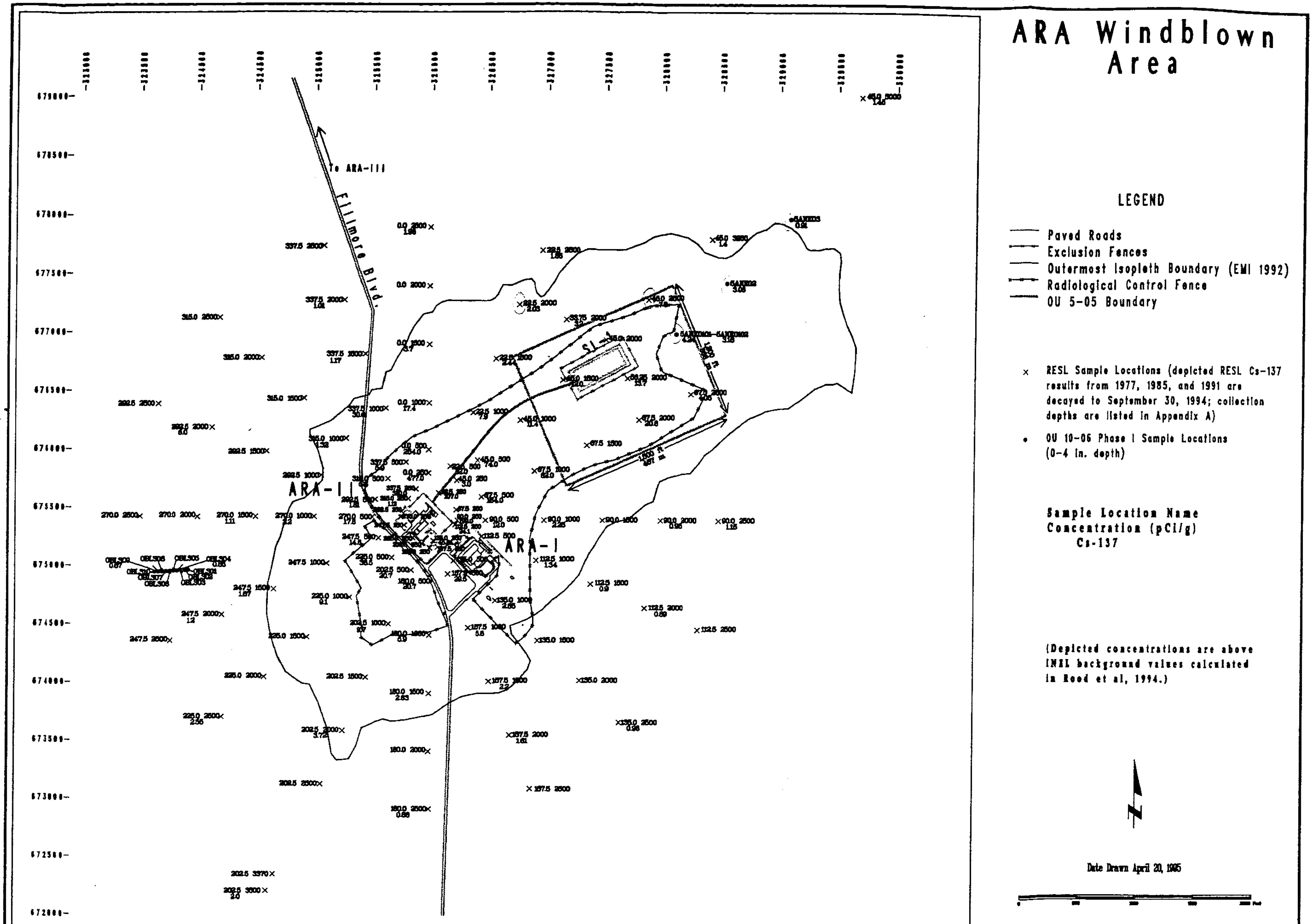


Figure 4. ARA isopleth, existing fences, and sample locations.

Table 3. Horizontal extent of contamination.

Contaminant	Horizontal extent
Cs-137	Concentrations above background are widespread in the windblown area, primarily adjacent to and in the predominant wind direction (southwest to northeast) from the ARA facility. Highest concentrations occur just northeast of ARA-II. The outer isopleth bounds the horizontal extent to 5 pCi/g. Concentrations above 5 pCi/g have not been detected outside of the isopleth, but several values above the background of 0.81 pCi/g have been.
Pu-238	Concentrations above background were detected in only two locations, leading to the conclusion that this constituent is limited in horizontal extent. Both detections were proximal to ARA-I.
Pu-239/240	Only one sample location, near ARA-I, yielded results above background, indicating that this constituent is not widespread.
Sr-90	Concentrations above background are widespread in the windblown area, primarily adjacent to and in the predominant wind direction (southwest to northeast) from the ARA facility. The outer isopleth bounds the horizontal extent to 1 pCi/g. Concentrations above 1 pCi/G have not been detected outside of the isopleth, but four values above the background of 0.50 pCi/G have been.
Co-60	Concentrations have been detected, primarily in soils within 152 m (500 ft) of the ARA facility. One detection (0.043 pCi/g) was located outside of the outer isopleth.
Eu-152	Horizontal extent cannot be estimated because only one data point is available for this constituent.
Eu-155	The only concentrations occur north of the ARA facilities and are not widespread throughout the remainder of the windblown area. The isotope was not detected outside of the outer isopleth.
U-233	Reported concentrations occur north of the ARA facilities and are not widespread throughout the remainder of the windblown area. One detection occurred outside of the outer isopleth.
U-235	Reported concentrations occur north of the ARA facilities and are not widespread throughout the remainder of the windblown area. Two detections occurred outside of the outer isopleth.

4.2 ARA Windblown Area Contaminant Fate and Transport

Routes of migration are limited to air and biota transport. Impact from wind transport is restricted to the top few inches of soil; migrating animals and insects provide a possible secondary transport mechanism. Surface water transport has not been identified as a potential route of migration because there is no surface water at ARA. Groundwater transport is not considered because contamination is limited to the top 10 cm (4 in.) of the surface soils, and there is no mechanism to drive constituents into the subsurface.

A conceptual site model was developed for the windblown soils area to identify contaminant release and transport mechanisms, affected media, and potential receptors. Suspension, intrusion, and radioactive decay are potential release mechanisms; air and soil are the transport mechanisms and affected media; current occupational personnel and future residents are the potential receptors. Future residential dermal exposure and ingestion of food crops and occupational dermal exposure are also included as potential exposure pathways.

The persistence of each COPC is governed by its half-life. The primary COPC, Cs-137, has a half-life of approximately 30 years. Sr-90, the secondary COPC, has a half-life of approximately 29 years.

4.3 Operable Unit 10-06 Baseline Risk Assessment

4.3.1 Human Health Evaluation

The human health evaluation consists of three major components:

- Exposure assessment: quantification of the type, magnitude, and duration of exposures to COPCs

- Toxicity assessment: identification of potential adverse effects and toxicity values for COPCs

- Risk characterization: evaluation of potential risks and hazards posed by COPCs for hypothetical receptors.

Standard information that applies to all BRAs in the OU 10-06 study are not summarized here (ARA is one of 19 areas addressed in the original draft OU 10-06 Report). In-depth discussion for these nonspecific parameters (standard default exposure scenarios, pathways, biotic uptake methodology, COPC intake equations, chronic radiation effects, and methodology for evaluation carcinogenic and noncarcinogenic effects) can be found in Section 1 of Jessmore et al. (1995), the revised OU 10-06 RI/FS report. Information specific to the exposure assessment, toxicity assessment, and risk characterization for the ARA windblown contamination site is summarized below.

4.3.1.1 Exposure Assessment. Data sets from the RESL, the Phase I sampling, and the July 1995 survey were used in this assessment. RESL samples, collected from depths of 1–5 and

5–10 cm (0–2 and 2–4 in.) were combined and averaged to make the results comparable to the Phase I samples collected from 0–10 cm (0–4 in.). The RESL data were decayed from the time of collection in 1977, 1985, and 1991 to 1994, when the Phase I samples were taken. The dose equivalent rate measurements collected in August 1995 were taken at the approximate location of each of the RESL sample locations. The areal distribution of these data is illustrated in the EDF in Figure 12-3 titled "Dose Equivalent Rates at ARA Windblown Area."

Detected radionuclides were screened to eliminate those that are indistinguishable from background. The background values from Rood et al. (1994) were used in the comparison. Based on this screening, Cs-137, Pu-238, Pu-239, Pu-240, and Sr-90 were retained for the risk assessment. Detected radionuclides that have no established background value were also retained; these include Co-60, Eu-152, Eu-155, U-233, and U-235.

Many dose equivalent rates collected from the ARA area are above the 20 μrem/hr established as the background value in Rood et al. (1994). Therefore, dose equivalent rates, useful for assessing the external exposure pathway, are included in the BRA.

To determine concentration terms for the BRA, the arithmetic averages of COPC detections were calculated, and the 95% upper confidence limit of the arithmetic mean was established for the dose equivalent rates and all COPCs except Cs-137. Kriging was performed on the Cs-137 data, and the maximum contour interval based on the kriging results, 135 pCi/g (see the figure titled "ARA Windblown Area Cs-137 Kriging Results" in the EDF), was determined. The upper confidence limit for Cs-137 is 16.7 pCi/g; therefore, using the maximum contour interval yielded by kriging is a conservative concentration term. Upper confidence limits for Eu-152, Eu-155, Pu-39, Pu-24, U-233, and U-235 exceeded the maximum concentration detected; therefore, the maximum concentration detected was used as the concentration term for these radionuclides. Uranium is the only COPC with a chemical toxicity greater than its radiotoxicity. To evaluate noncarcinogenic effects from uranium, the maximum detection of U-238 was used to establish a concentration because it results in a higher nonradioactive soil concentration than other uranium isotopes. Table 12-9 in the EDF lists each COPC and the concentration term used in the BRA.

Concentrations of COPCs in air were developed using site-specific data. The mass loading of 10-μm particulates in air for the ARA is approximately 6E-06 g/m^3. The air concentrations for Cs-137 and Sr-90, the primary and secondary COPCs, are 8.1E-04 and 3.4E-05 pCi/m^3. Table 12-10 in the EDF contains the air concentrations for each COPC.

Intakes were calculated using standard intake equations. These are not presented here, but can be found in Section 1 of the OU 10-06 RI/FS Report.

4.3.1.2 Toxicity Assessment. Toxicity values were calculated using standard methodology; Section 1 of the OU 10-06 Report contains a detailed discussion. All COPCs (except uranium) were either detected above background or had no established background value. The slope factors used to evaluate carcinogenic risks are given in Table 12-11 in the EDF.

4.3.1.3 Risk Characterization. Two potential occupational exposure pathways were examined: ingestion of soil and inhalation of fugitive dust, for each of two time frames (current and 100 years in the future). Three future residential exposure pathways, ingestion of soil, inhalation of fugitive dust, and ingestion of food crops, were assessed for each of two time frames (30-year and 100-year future). The external exposure pathway was eliminated because the dose equivalent rates around ARA were all below background. Dermal contact was not evaluated because toxicity information for COPCs was either indicative of negligible risk or was not available. Groundwater ingestion was screened out due to the restriction of contamination to the top few centimeters of soil and the lack of a mechanism to drive contaminants to groundwater.

A quantitative risk value for each COPC and each pathway was calculated only if a toxicity value for that COPC and pathway was available. Qualitative evaluations were performed for those COPCs and pathways that did not have established toxicity values.

Noncarcinogenic effects are quantitatively evaluated based on the hazard quotient relative to unity. Carcinogenic risks are quantitatively evaluated and compared to the National Contingency Plan target risk range of 10^{-6} to 10^{-4}. The methods used in the human health risk assessment follow EPA guidance (EPA, 1989), and the risk values presented represent incremental individual lifetime cancer risks from exposure to COPCs. The RESRAD computer code was used to calculate risks for the soil-ingestion and fugitive-dust-inhalation pathways. Additional details concerning the application of standard risk methodology to evaluate carcinogenic and noncarcinogenic effects are presented in Section 1 of Jessmore et al. (1995). RESRAD input and output files and spreadsheets for the food crop ingestion exposure pathway appear in Appendices D and E of the EDF.

The risks and hazard quotients (uranium only) for the current occupational scenario are given in Table 12-12 of the EDF. The highest risk across the soil ingestion and inhalation of dust pathways is 1E-06 and is primarily due to ingestion of soil contaminated by Cs-137. Carcinogenic risks from all other COPCs for these two pathways are below the 10^{-6} to 10^{-4} risk range established by the National Contingency Plan. Risk due to external exposure is 1E-03. The hazard quotient for uranium is 5E-04, well below the target hazard quotient of 1.

Results for the 30-year future residential scenario are given in Table 12-13 of the EDF. The highest risk across the soil ingestion and inhalation of dust pathways is 7E-05. The main contributors to risk are Cs-137 and Sr-90. Highest risks are 2E-06 from soil ingestion and 2E-05 from food crop ingestion due to Cs-137, and 5E-05 from food crop ingestion due to Sr-90. For these two pathways, carcinogenic risks from all other COPCs are below the 10^{-6} to 10^{-4} risk range established by the National Contingency Plan. The risk due to external exposure is 9E-03. The hazard quotient for uranium is 1E-02, well below the target hazard quotient of 1.

The chemical toxicity due to fugitive dust inhalation of uranium was evaluated qualitatively because there is no toxicity value available for the inhalation pathway. For the occupational scenario, the maximum calculated air concentration (2.3E-08 mg/m^3) of soluble uranium compounds at ARA was compared to an Occupational Safety and Health Administration limit comprised of a time-weighted average of 5E-02 mg/m^3 (29 Code of Federal Regulations 1900.1000) and found to be well below the occupational limit. This information indicates that there is no hazard from the inhalation of uranium for the occupational scenario. The residential scenario was not specifically addressed, but presumably would have similar results.

The 100-year future occupational scenario was evaluated; results are given in Table 12-14 of the EDF. External exposure was screened out using the assumption that Cs-137 generates the dose equivalent rate measurements. The maximum current reading, 220 μrem/hr, is below the 100-year occupational scenario PRG of 543 μrem/hr. Risks in other pathways are below the NCP risk range.

The 100-year future residential scenario was also assessed. Table 12-15 in the EDF list the results. Based on the 30-year results, risks for Cs-137 and Sr-90 only are presented in Table 12-15 of the EDF. These radionuclides exceeded the preliminary remediation goals established in the OU 10-06 feasibility study.

4.3.2 Ecological Risk Assessment

The methodology presented in VanHorn et al. (1994) was used to assess potential risk to ecological receptors at the ARA windblown contamination area. The pathway of concern is exposure through the surface soils, which are limited to the top 10 cm (4 in.). The ecological-based screening level per receptor of concern for each COPC identified is presented in Appendix H of the OU 10-06 Report, and show that mean levels of all COPCs do not exceed their corresponding ecological-based screening levels for surface soils, even if summed across contaminants. Only two animal concentration factor values for radionuclides are available; a concentration factor value of 1 was used for any radionuclide that did not have a site-specific value. Even using a concentration factor of 10, there is no indication of ecologic risk due to the ARA windblown contamination site. Therefore, it is highly unlikely that COPCs identified for this site will cause adverse effects to populations of exposed ecological receptors.

4.3.3 Uncertainty

Because no values are known exactly in a quantitative risk assessment, examination of uncertainty provides a description of the confidence in risk estimates. Sources of uncertainty include incomplete information, disagreement regarding specific values, imprecision in analyses, variability in values used, and modeling assumptions. Simplifications and approximations used to make an analysis feasible or cost-effective may also add to uncertainty.

Key sources of uncertainty for the ARA windblown contamination area risk assessment were identified and examined for the impact they may have on the risk assessment results. Most of these uncertainties cannot be quantified, so a qualitative evaluation was performed. The key sources of uncertainty are those variables and assumptions that contribute most to the overall uncertainty.

The EDF contains a detailed qualitative characterization of the potential magnitude of the effect of each uncertainty factor at the ARA site. Each of the six major steps of the risk analysis, listed below, incorporated factors that contribute to overall uncertainty.

1. Environmental sampling and analysis - Ten factors were evaluated: five have a low potential for over- or under-estimating risk, one has a moderate potential for under-estimation, one has a low potential for under-estimation, one has a low potential for over-

estimation, one was unranked with a possibility of under-estimating, and one was unranked with a potential for over-estimating risk.

2. Fate and transport - Three factors were evaluated: each have a moderate potential for over-estimating risk.

3. Exposure assessment - Four factors were evaluated: two have a moderate potential and one has a moderate-to-high potential for over-estimating risk, and one has a low-to-moderate potential for under-estimating risk.

4. Toxicity assessment - Two factors were evaluated: one has a low potential for over- or under-estimating risk, and one has a moderate potential for under-estimating risk.

5. Risk characterization - One factor was evaluated with a low potential for under-estimating risk.

6. Ecological risk assessment - Three factors were evaluated: one has a moderate potential for over-estimation, one has a high potential for over-estimation, and one is ranked high for over-estimation and low for under-estimation of risk.

5. CONCLUSIONS

The BRA was performed using all available data from the RESL and OU 10-06 Phase I data sets, and from the dose equivalent rates measurements obtained in July 1995. The EDF contains figures that illustrate the areal distribution of these data and kriging results for Cs-137. The higher concentrations are located to the north and northeast of ARA-II, but are not distributed much beyond a distance of 305 m (1,000 ft) from the facility. The soil area included in the SL-1 RI/FS is approximately bounded by a line through the 22.5-degree 1,500-ft and the 112.5-degree 1,500-ft sample locations. The data from the northeastern lobe of the contaminated soil area are lower on average than those in the southwestern end. Therefore, the source-term concentration, if calculated only for the northeastern lobe, would be much lower than the source-term concentration presented in the EDF for the entire soil area. Calculated risks would be correspondingly lower. This supports the conclusion that risks for soil ingestion and inhalation of fugitive dust, already within the NCP acceptable risk range, are of even less concern for the specific area around the SL-1 burial ground than for the entire windblown contamination site.

Hazards due to external exposure were screened from the original BRA on the basis of dose equivalent rates acquired at remote locations. Therefore, new dose equivalent rate measurements were obtained. An examination of Figure 12-3 in the EDF (titled "Dose Equivalent Rates at ARA Windblown Area") shows many results above the 20 μrem/hr background level. However, the all data above background occur within the isopleth also illustrated in the figure. All of the dose equivalent rate data in the northeastern portion of the plume around the SL-1 burial ground are at or below background. Therefore, surface consolidation should not be necessary to confine surface soils around the SL-1 burial ground. Of note is the fact that the soil concentration is an average; particle picking indicates that randomly located hot particles may still be present.

In conclusion, there are no unacceptable risks from surface soils around SL-1. Standard health and safety measures should be sufficient to ensure worker safety during all cap construction activities, including foundation preparation, as long as the existing soil cover, at a minimum, is maintained. This incorporates the assumption that the buried contaminated soils and debris will not be disturbed. To avoid intrusion into the buried wastes, foundation preparation must include leveling the site by adding, not removing soils. Disturbance of the contaminated materials would nullify this assessment and could result in very high exposures to workers.

6. REFERENCES

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ACRONYMS

ARA	Auxiliary Reactor Area
BRA	baseline risk assessment
COPC	contaminants of potential concern
EDF	engineering design file
FS	feasibility study
INEL	Idaho National Engineering Laboratory
OU	operable unit
RESL	Radiological and Environmental Sciences Laboratory
RI	remedial investigation
SL-1	Stationary Low Power Reactor Number 1